APPENDIX C

INFORMATION FROM THE INTERNATIONAL SNOWMOBILE MANUFACTURERS ASSOCIATION

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HAL R. HORTON (1944-1998)

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August 7, 2001

Via Federal Express

Steve Iobst
Acting Superintendent
c/o Moose Warehouse
Grand Teton National Park
Moose, WY 83012

Re: ISMA Documents

Dear Mr. Iobst:

Enclosed are initial documents from the International Snowmobile Manufacturers Association ("ISMA") containing general information and data regarding exhaust and noise emissions of new snowmobile technology. ISMA submits these documents in compliance with Paragraph 6 of the Settlement Agreement between ISMA and the Park Service of June 29, 2001. ISMA submits these documents only for the purpose of the Park Service determining the environmental impact of snowmobiles as it relates to winter use management in Yellowstone National Park; Grand Teton National Park; and the John D. Rockefeller Jr., Memorial Parkway. ISMA understands that the Park Service may analyze and share this information with contractors and cooperating agencies for the purpose of preparing the Supplemental EIS called for in the Settlement. The Park Service will include this information in the Administrative Record of this proceeding.

The enclosed information is what is currently available and releasable. ISMA may supply additional information and data as it becomes available. Neither ISMA nor any of its members intend to be legally or otherwise bound by the information or data contained in these documents, or to waive or affect any privilege or proprietary interest in the documents and data in them. We ask that you include this letter with any release of this information.

We hope that the Park Service finds this information useful. If you have any questions, please contact me.

Sincerely,

BIRCH, HORTON, BITTNER AND CHEROT

William P. Horn

Enclosures

cc: (letter only)
Martin LaLonde
Tom Davidson
Paul Turcke

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International Snowmobile Manufacturers Association Settlement Agreement, Section 6 Information and Data (August 2001)

In accordance with Section 6 of the June 29, 2001 Settlement Agreement between the National Park Service and the International Snowmobile Manufacturers Association ("ISMA"), et al., ISMA and its members present the following information and data. As additional information and data becomes available, ISMA will provide it to the Park Service. In particular, the U.S. Environmental Protection Agency is currently considering the exhaust emissions issue and more information arising out of that proceeding should be available in the next month or so.

In addition to the four-stroke engine, the enclosed documents discuss other technological improvements, such as fuel-injected two-stroke engines, catalyst technology, and modifications to two-stroke engines, which will enable manufacturers to produce and market significantly cleaner snowmobiles. All the manufacturers expect to continue to work on these and other technologies as they develop in an effort to improve exhaust and sound emissions and other aspects of their products.

The technological improvements discussed in the enclosed documents will significantly improve exhaust and sound emissions. These new technologies are currently available and are expected to be available in the near future. For example, last winter in Yellowstone National Park, the rental fleet used 50 four-stroke machines. As Yellowstone is a primary market for new technologies, more units should be available for use in Yellowstone this upcoming winter and in future winters.

These improvements, in conjunction with other steps the Park Service can take, should address concerns over alleged problems with exhaust and sound emissions. The Park Service should devise reasonable regulations concerning snowmobile use in Yellowstone and Grant Teton National Parks and the John D. Rockefeller Jr., Memorial Parkway with a forward looking view toward these technological advances. In this way, the Park Service can devise a system to serves the many Park Service goals and purposes.

If the Park Service wants particular information not provided in these documents, please request them and ISMA will do everything it can to provide the information. ISMA and its members stand ready to help in this process in any way possible.

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ARCTIC CAT®

August 3, 2001

Ed Klim
ISMA
1640 Haslett Rd., Suite 170
Haslett, MI 48840

Dear Mr. Klim:

In accordance with section E paragraph 6 of the settlement agreement between ISMA and the Department of the Interior dated in July of 2001, Arctic Cat Inc submits the following information regarding exhaust and noise emissions from new snowmobile technology that Arctic Cat may or will introduce in the future.

Four-stroke. Arctic Cat has adapted a carefully selected automotive engine for suitable performance in a snowmobile application which will be in full production for the 2002 model year. This engine technology made significant improvements to both exhaust and sound emissions and this was demonstrated by 50 units that were operated in a rental fleet in Yellowstone National Park during the 2000/2001 winter season. Likewise, this engine produced impressive results when scientifically tested. Sound has been measured at less than 75 dB on the A weighted scale using the SAE J192 test procedure. Exhaust emissions have been cut by more than one half for CO and three quarters for HC with respect to EPA's baseline[1] for snowmobiles. It is likely that Arctic Cat will continue to produce similar or other types of four-stroke engines having various sound and exhaust emissions outputs that we expect to be in a range considered excellent by two-stroke standards.

Two-stroke with direct fuel injection (DI). Arctic Cat has successfully applied Ficht Fuel Injection (DI) to a personal watercraft engine which was marketed in the 1999 model year. We have since exited the PWC market but continue to develop direct fuel injection for snowmobile applications. This work has shown that emissions for both HC and CO can be reduced by over one half relative to the EPA baseline from a prototype unit. DI technology alone provides no direct positive or negative effect on sound emissions.

Catalyst. Arctic Cat has performed limited lab testing of catalyst technology. Reductions of about one half have been achieved for HC alone, however, high exhaust system temperatures, CO generation, extremely poor durability, and low value to the consumer have not motivated

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[1] United States Environmental Protection Agency. Memorandum to Docket A-98-01, Summary and Analysis of Comments for Notice of Proposed Finding: Control of Emissions from Nonroad Spark-Ignition Engines Rated above 19 Kilowatts and New Land-Based Recreational Spark-Ignition Engines.

ARCTIC CAT INC., P.O. BOX 810, 601 BROOKS AVE. S., THIEF RIVER FALLS, MN 56701 TELEPHONE (218) 681-8558 FAX (218) 681-3162

additional development of this technology. Limited success with catalysts on snowmobiles has been demonstrated by the universities competing in the Clean Snowmobile Challenge, however, it is difficult to predict if it is economical or even possible to develop safe, fully functional, and durable catalysts for production snowmobiles. No significant impact on sound emissions would be expected by the addition of catalyst technology.

Engine modification. Ongoing efforts to reduce emissions from existing two-stroke engines indicate that moderate reductions are possible though various engine modifications. A good example would be Arctic Cat's Electronic Fuel Injection (EFI) system showing some reductions of exhaust emissions are possible from more precise metering of fuel. Modification to scavenging and exhaust flow may also have a positive impact on exhaust emissions.

Sound emissions. We know of little new technology specifically targeting sound emissions, simply, sound reduction is a product of developmental effort along with careful management of weight, cost, and performance goals. The effectiveness of this approach is often underestimated. Sound standards were adopted by the industry when the largest sleds were 440 cc. Since then snowmobile engines have not only grown as large as 1000 cc, but the sleds ride much higher off the snow exposing the exhaust outlet and moving drive and suspension components to line-of-sight "view" of the sound meter. Given these changing conditions it is a credit to industry and it's engineers to have controlled sound emissions to level set over 25 years ago. The industry continues to be motivated to reduce sound emissions. Arctic Cat expects that future two-stroke snowmobiles will be quieter than current models and our 4-stroke technology will continue to produce exceptional results.

Sincerely,

Christopher W. Wright
Project Engineer, Exhaust Emissions

4 Stroke

ARCTIC CAT®

What Snowmobiling's All About.™

The cleanest, most quiet snowmobile in our lineup. Very low emissions, no blue smoke. Its reduced sound output lets you hear the skis skim across the snow.

The revolutionary 660cc liquid-cooled, 4-stroke C TECH 4™ engine with electronic fuel injection offers fuel efficiency of 20–25 mpg at trail speeds — truly in a class of its own.

The lightweight engine creates plenty of torque and allows smooth acceleration up to touring speed and great handling.

Features Arctic Cat's unique AWS™ V front suspension and FasTrack® Long-Travel Rear Suspension System for a superior ride.

4Stroke

Presenting the revolutionary C TECH 4™ engine. It features: EFI, electric starting, and ACT™ sound reduction. Its fuel economy is estimated as high as 20-25 miles per gallon at trail speeds. Its light weight makes our 4-Stroke sled comparable in weight to other sleds in the touring class.

specifications

ENGINE	SUZUKI 4-STROKE (C TECH 4)
DISPLACEMENT	660 CC
BORE & STROKE	68.0 X 60.4
HORSEPOWER	45
# OF CYLINDERS	3
COMPRESSION RATIO	10.5:1
LUBRICATION	WET SUMP
COOLING	LIQUID-COOLED
CAPACITIES: OIL, COOLANT	OIL–2.5 QTS., COOLANT–1 U.S. GAL.
IGNITION	CDI
CARBURETION	EFI
INTAKE	(4 VALVES PER CYL.) — DOHC (DUAL OVERHEAD CAMSHAFT)
EXHAUST	SINGLE MUFFLER
ALTERNATOR (WATTS) AT 5000 RPM	770
DRIVE CLUTCH	ARCTIC (RPM SENSING)
DRIVEN CLUTCH	ARCTIC (ROLLER CAM)
FRONT CHASSIS	ALUMINUM
REAR CHASSIS	ALUMINUM
SKI STANCE	41"
SKI MATERIAL	BLOW-MOLDED PLASTIC
SKI CARBIDES	STANDARD
FRONT SUSPENSION	AWS-V DOUBLE-WISHBONE A-ARMS WITH RYDE-FX SHOCKS, ADJUSTABLE PRELOAD SPRINGS AND SWAY BAR
TRAVEL	8.4"
REAR SUSPENSION	FASTRACK LONG-TRAVEL SYSTEM SLIDE-RAIL, ADJUSTABLE TORSION SPRINGS, RYDE-FX SHOCKS, FIBERGLASS OVERLOAD SPRINGS, TORQUE SENSING LINK REAR ARM
TRAVEL	13.3"
TRACK	RUBBER/FIBER-REINFORCED
WIDTH X LENGTH X LUG	15" X 136" X .75"
BRAKES	HYDRAULIC DISC
FUEL CAPACITY	13 GAL.
LENGTH	131"
HEIGHT (TOP OF WINDSHIELD)	47"
WIDTH	48"
ESTIMATED DRY WEIGHT	610 LBS.
NUMBER OF RIDERS	2
HEADLIGHT	HALOGEN (3-BULB)
TACHOMETER	STANDARD
SPEEDOMETER	STANDARD
TRIP ODOMETER	STANDARD
GAS GAUGE	ELECTRICAL
OIL INDICATOR LIGHT	STANDARD
COOLANT GAUGE	STANDARD
ELECTRIC START	STANDARD
REVERSE	STANDARD
MIRRORS	STANDARD
HAND WARMER	HI/LOW
THUMB WARMER	HI/LOW
MOUNTAIN STRAP	N/A
HIGH WINDSHIELD	STANDARD
2-PASSENGER SEAT WITH BACKREST	STANDARD/DETACHABLE
RACK	STANDARD
HITCH	OPTIONAL
ACCESSORY OUTLET	STANDARD
ENGINE BLOCK HEATER	STANDARD
HOOD COLOR	ASPEN GREEN METALLIC

Polaris Industries, Inc.
Input to the International Snowmobile Association (ISMA)
Pursuant to Provision E.6 of the ISMA / NPS Settlement Agreement

Current New Technology Products

Polaris has developed a new two-passenger 4-stroke snowmobile, the Indy Frontier Touring model, that will be introduced to the market in Model Year 2002 (see attached brochure). The Indy Frontier Touring model is a cleaner, quieter, and more environmentally friendly snowmobile featuring a four-stroke engine designed for snowmobiles. Polaris will begin limited production of this model in November 2001, and it will be available through select rental operators in the Yellowstone National Park area by December 2001. The Indy Frontier model is expected to become available to consumers and all fleet operators during the 2002-2003 season.

The engine package is a liquid cooled 4-stroke, 780-cc twin cylinder engine with closed loop EFI induction. It is equipped with a feedback system and oxygen sensor, which automatically compensates for ambient conditions and altitude. Standard equipment also includes an engine block heater for easier severe cold-weather starting. The engine delivers approximately 50 hp at 6,000 RPMs. The engine was designed for snowmobile use in order to accommodate mounting the engine low in the chassis to provide stability, easy handling, and the level of steering control necessary in a snowmobile.

A primary market for the Indy Frontier Touring model is the snowmobile rental fleet market in the Yellowstone area. Other target owners include individual consumers who prefer the reduced sound, emission, and operating costs that the Indy Frontier four-stroke engine provides. At $7,699, the Indy Frontier's suggested retail price represents a 36% premium versus a comparable horsepower Polaris two-stroke model due to the added costs of the four-stroke engine. The price premium may limit the Indy Frontier's broad individual consumer appeal, however, the vast majority of snowmobile rental fleet operators have stated that their future purchases will be powered by reduced emission engines.

40-60 horsepower, two passenger snowmobiles such as the Indy Frontier Touring model represent approximately 5% of last season's U.S. Industry total snowmobile retail sales of 140,624 units. All configurations of 40-60 horsepower snowmobiles represent approximately 14% of U.S. Industry retail sales and are far and away the most commonly used snowmobiles by fleet operators surrounding Yellowstone. Moreover, a very high percentage of snowmobiles traveling in Yellowstone come from fleet operators.

The engine exhaust emissions and vehicle sound emissions of the Indy Frontier Touring model are significantly reduced compared to a typical carbureted 2-stroke design. Although the final engine calibration is still being refined, preliminary emissions data on the Indy Frontier indicate that it will achieve, as an individual model, the 30% exhaust emission reduction of both HC and CO proposed by the industry to EPA for fleet average

implementation in 2006. In addition, noise sound pressure levels are as much as 4-5 dB(a) lower than a comparable carbureted 2-stroke model, measured using the industry-standard SAE J192 test method.

Future New Technology Products

While requiring time and a very large financial resource commitment in terms of not only engines but also exhaust and chassis systems, Polaris expects to expand its lineup of cleaner and quieter snowmobiles in the future. To accomplish this, the company is evaluating its four-stroke offering, calibration changes to existing engines, and fuel injection technology.

FRONTIER TOURING

- New Polaris liquid cooled 4 stroke twin cylinder engine is quiet, efficient and clean.
- Closed loop EFI induction provides great throttle response and quick starts regardless of altitude or temperture and great fuel economy from the 48 HP engine.
- Polaris designed engine assembled in Osceola, Wisconsin.
- Designed specifically for snowmobile applications giving it a lower center of gravity and excellent cold weather starting.
- Electric start, reverse and a block heater standard.
- Premium EDGE™ Independent Front Suspension (IFS) with Controlled Roll Center (CRC) design for improved handling and ride.
- EDGE 136 Touring rear suspension with almost 12"of rear travel gives great ride.
- Comfortable 2-up seat with adjustable backrest.
- Cargo rack is standard.

POLARIS®
The Way Out.

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September 28, 2001

Mr. Steven Iobst
Acting Superintendent
Grand Teton National Park
P.O. Box 170
Moose, WY 83012

Dear Mr. Iobst,

Thank you for your letter of September 10, 2001. As you may know the International Snowmobile Manufacturers Association (ISMA) in a letter dated September 10, 2001 to Mr. David Smith, Counselor to the Assistant Secretary for Fish, Wildlife and Parks, addressed a number of the matters you raised. This letter supplements the comments in the Smith letter regarding the provision of technical information regarding substantial reductions in emissions from new snowmobile technology. As you may know, the Environmental Protection Agency (EPA) has been working with ISMA on new snowmobile fleet emission standards. Those efforts yielded publication of an EPA NPRM on September 14, 2001 to achieve reductions in snowmobile emissions. EPA noted that the proposed emission reductions will reduce the presence of haze and other air pollution in national park units. ISMA remains committed to working with EPA, and toward cleaner machines, notwithstanding the fact that snowmobile emissions make almost insignificant contributions to air pollution. Latest data indicate that snowmobiles produce nationally only 0.55 percent of carbon monoxide (CO), 0.00547 percent of nitrogen oxide (NOx), and 1.22 percent of hydrocarbons (HC) emissions.

As indicated in our previous letter, the new four-stroke machines are in production. As soon as these new machines are assembled, testing for emissions will be conducted and those results immediately provided to you. We anticipate being able to provide these data in a matter of days. Test results on prototype models have indicated that four-stroke sleds are capable of HC emission reductions in the 70-95 percent range, with CO emission reductions of 60-80 percent. Direct fuel injection two-stroke engines, which are not in production and may or may not be economically feasible, likely, can achieve respective reductions of 50-60 percent for both HC and CO.

See EPA NPRM, Sept. 14, 2001. Since the National Park Service has ordered 22 new four-stroke machines, you can also test the models that will be in your possession to verify the accuracy of the manufacturers' test results. The use of the most current verified technological information in the SEIS clearly furthers the purposes of the National Environmental Policy Act.

ISMA is convinced also that these current technological improvements are of a type not fully considered in the original EIS and ROD. These improvements will be available immediately, not in the 2008-09 time frame considered in the few original EIS alternatives that addressed new technology (mostly in vague terms), especially if the rental fleet converts exclusively to four-stroke machines this year or next. In addition, the improvements appear to be greater than speculated in the original EIS. Thus, the Park Service should not discount these improvements as already considered. In short, it is hard to see how use of these new technologies, especially by the rental fleet, in addition to other reasonable restrictions, would not eliminate the "impairment" the Park Service perceived that snowmobiles were causing in the three Parks.

Your letter requested considerable information. The following are responses to those requests.

1. Baseline information for existing snowmobiles was presented to the US-EPA enabling them to publish their final findings. The US-EPA determined that the CO baseline for two-stroke snowmobiles is 397-g/kW (h). ISMA agrees with these baseline data. The EPA also determined that the HC baseline is 149-g/kW (h). The US-EPA used data from a variety of sources to establish their baseline. The EPA should be contacted directly to obtain that data. The EPA published their summary and analysis on November 17, 2000 in which they discussed how they determined the emission factor baseline.

2. Emissions factors of new technology machines, being introduced into the marketplace this year and in the near future, vary dependent on the technology being used and the degree of emission reduction necessary to achieve emission average standards. As noted above, emissions information will be provided shortly to you.

3. Information regarding snowmobile particulate matter emissions does not exist. There is no accepted protocol for testing particulate matter emissions from snowmobiles. Moreover, EPA has declined to require testing for particulates in part because of the substantial costs associated with establishing particulate measurement capabilities. As also noted by the EPA, any reduction in HC emissions (e.g., 70-95 percent for four-stroke engines) simultaneously limits and

or reduces particulate matter emissions. Additionally, the use of biodegradable synthetic oil in two-stroke engines, as is being prepared, significantly reduces particulate emissions.

4. A deterioration factor for snowmobiles has not been established. EPA is requiring emissions compliance over the full useful life of snowmobiles. Different technology types deteriorate at different rates and this will be determined for each engine family under the EPA.

5. Testing has not been done nor does EPA require it for subclasses of hydrocarbons such as Benzene or Toluene. No other producers of recreational engines (i.e., outboard motors) have been required to test for specific emissions of these hydrocarbons, which are relative to the HC count in the overall baseline.

6. Conclusions reached by Southwest Research Institute and the Montana Department of Environmental Quality show that emissions from snowmobile engines using bio-based fuels and lubricants drop considerably. When gasohol is used in a standard two-stroke snowmobile, there is a 16 percent drop in HC and 9 percent drop CO compared to standard endoline fuel use reports as used in EPA tests. This emission reduction occurs with no technology adjustments. It is our understanding that Yellowstone National Park and adjacent communities have been and will continue to use gasohol for snowmobiles entering into the park. The manufacturers have no other test data on the effects of alternative fuels and lubricants in new technology engines.

7. ISMA anticipates the mix of snowmobiles that enter the park will change in the direction of cleaner and quieter machines over the near term. The pending EPA snowmobile emission regulation will result in a substantially cleaner fleet of new snowmobiles. We anticipate that a segment of the public will purchase these cleaner snowmobiles. In addition, normal turnover in snowmobiles purchased by the public will steadily and incrementally increase the percentage of never cleaner sleds in use. We are working to refine our projections but it is safe to conclude that in no more than five years a combination of cleaner sleds and normal turnover will reduce snowmobile emissions within the three parks.

8. The manufacturers will provide information in the g/kW (h) format for operational speeds and idle emissions in the tests on the new clean production models. We are unable, however, to provide accurate empirical information in the g/mi. format. Calculation of the latter numbers in dependent on a number of variables including vehicle type, speed, terrain, altitude, etc.

9. New production four-strokes are significantly quieter than standard two-stroke machines. Once adequate snow cover is available, testing will proceed on sound levels for the new machines using the standard SAE test procedures. That data will be provided to you.

We trust that these answers are responsive to your requests. Thank you and we look forward to talking with you soon. Attached is the Development and Validation of the Snowmobile Engine Emission test procedure. The SAE paper discusses the five-mode duty cycle and supports the enclosed information. Any emissions data noted in this letter can also be verified by the US-EPA.

Sincerely,

BIRCH, HORTON, BITTNER
AND CHEROT

William P. Horn
Counsel for International Snowmobile
Manufacturers Association

Enclosure

cc: David Smith

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October 9, 2001

Mr. Steve Iobst
Acting Superintendent
c/o Moose Warehouse
Grand Teton National Park
Moose, WY 83012

Re: Snowmobile Emissions Data

Dear Mr. Iobst:

Four-stroke snowmobile production will commence in the next week or so. As previously indicated, once production models are available emissions tests will be performed and results provided to the Service. We had hoped to have this information to you by now.

We are aware of the time constraints under which the Supplemental Environmental Impact Statement ("SEIS") is being prepared. Arctic Cat has authorized the release to you of earlier test results on its four-stroke prototypes to bridge the information gap between now and data availability on production models.

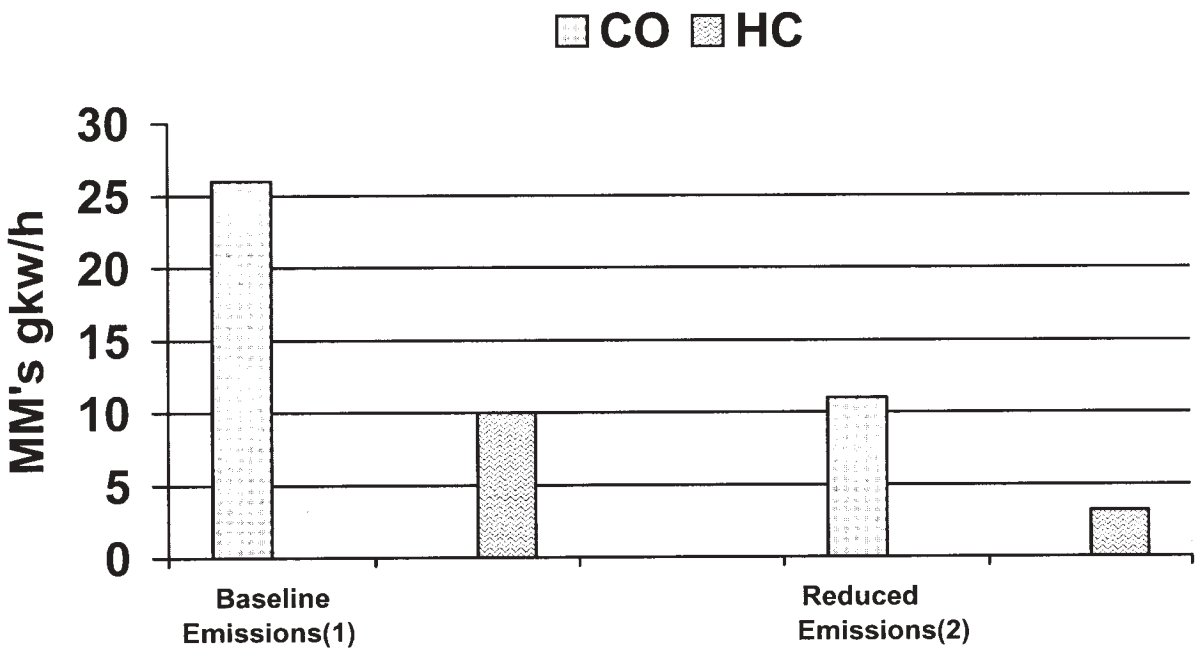
The enclosed data demonstrates that the new four-stroke technology will eliminate any emission problems associated with snowmobile use in Yellowstone and Grand Teton National Parks. The following is a comparison of four-stroke emissions from an automotive-based engine compared to the EPA baseline for existing two-stroke technology:

	HC gkw/hr	**CO gkw/hr**
EPA Two-Stroke Baseline	**149.00**	**397.00**
Four-Stroke Prototype	**6.32**	**68.20**

The automotive-based four-stroke engine emissions are 95.8% less for HC and 82.8% less for CO. It is expected that test results will be similar for comparable production models.

Existing snowmobile use in Yellowstone and Grant Teton Parks has caused no violations of ambient clean air standards. Nonetheless, rapid conversion of the rental fleet (accounting for 70% of entries into the parks) to new technologies, including the four-stroke models, will substantially and dramatically curtail emissions. Such a management regime is likely to rapidly reduce HC emissions associated with snowmobiles by approximately 67% and CO emissions by 58%:

REDUCTION OF SNOWMOBILE EMISSIONS IN YELLOWSTONE/GRAND TETON VIA USE OF FOUR-STROKE SLEDS IN RENTAL FLEET



(1) 65,000 Entries EPA Baseline Per Sled – 149 gkw/h-HC; 397 gkw/h-CO
(2) 65,000 Entries; 45, 500 Entries (70%) on Rental 4-stroke Sleds

Substantially reduced emissions resulting from such a management regime will ensure that there will be no violations of ambient air standards or any impairment of park resources.

Sincerely,

BIRCH, HORTON, BITTNER AND CHEROT

William P. Horn
Counsel to International Snowmobile Manufacturers Association

Enclosure

G:\101238\3\KNJ1220.DOC

ARCTIC CAT®

October 3, 2001

Mr. Steven F. Iobst
Acting Superintendent
c/o Moose Warehouse
Grand Teton National Park
Moose, WY 83012

Dear Mr. Iobst:

In response to your September 10, 2001 letter, we are providing available emissions data. As you may know, we agreed to provide emissions data for our 4-stroke snowmobile after we begin 4-stroke production in October, at which time the most up to date engines (built with production tooling) will be available for testing. In order to assist your short term needs in drafting the SEIS, we can provide some preliminary data at this time (see attached).

The first data sheet is an earlier emissions test conducted on our prototype 4-stroke snowmobile engine. Some minor changes have been made to this engine design since this test. Also the intake air temperature during the test was out of specification, however, we believe these results are close to what we will see later this month, when more rigorous testing will be conducted for the park.

The remaining data sheets are from tests conducted on baseline two-stroke snowmobiles engines tested by Arctic Cat. The other three manufacturers each conducted similar tests on four of their engines. This data was submitted to ISMA for analysis and averaging. The sales weighted average of the16 engines was submitted to EPA. EPA chose to do their own analysis and came up with nearly identical results[1]. Although not required by paragraph 6 of the settlement agreement, we are providing this data because you asked for it specifically.

In regard to items 3 thru 6, we do not have any data. The answer to question 7 would only be a guess, depends on the content of EPA's final rule, and could not be released because it would help our competitors. We have not measured emissions in units of g/mile for question 8, a conversion to calculate emissions into these units depends on some variables unknown to the specific snowmobiles. We do not have data for question 9, this would have to be collected when there is snow.

[1]US EPA, Memorandum to docket A-98-01: Summary and Analysis of Comments for Notice of Proposed Finding: Control of Emission from New Nonroad Spark-Ignition Engines Rated above 19 Kilowatts and New Land-Based Recreational Spark-Ignition Engines, November 17, 2000.

I hope this helps some of your analysis. Feel free to contact me for clarification of attached data or Bill Horn for further questions.

Sincerely,

Christopher Wright
Project Engineer, Exhaust Emissions

EXHAUST EMISSIONS ANALYSIS, Test Cell # 3

Engine Tested: 660 4-stroke ISMA emissions test, engine serial # SNK6A-1546717

Test Date: 2/29/00 **Report Date:** 10/3/2001 **Run Number:** 1525

Mode	SPEED	Torque	Power	Intake	Baro.	Water Vapor	Relative	EPA "f"	Fuel Pres.	Fuel Flow	BSFC	Run
	rpm	N-m	kW	Air, Deg. C	kPa	Press, kPa	Humidity	Factor	Psi	g / hr	lbs / hp-hr	Number
1	6150	48.4	31.1	29.4	97.0	0.56	13.6	1.036	0.7	10233	0.54	1525
2	5228	25.1	13.7	29.4	97.0	0.55	13.5	1.036	0.8	4716	0.56	1525
3	4613	15.5	7.4	29.1	97.1	0.55	13.6	1.036	0.8	2965	0.66	1525
4	3995	9.2	3.8	28.8	97.1	0.54	13.8	1.034	0.8	1916	0.83	1525
5	993	1.3	0.1	28.7	97.1	0.54	13.8	1.034	0.8	339	7.33	1525

Mode	THC	CO	CO2	O2	NOx	Mass Emissions, g/hr			Weighted Mass Emissions, g/hr			Weighted Fuel Flow
	ppm C1 wet	% wet	% wet	% wet	ppm wet	HC	CO	NOx	HC	CO	NOx	g / hr
1	2174	2.62	11.26	0.18	1524.0	158	3840	367.04	19	461	44.05	1228
2	2347	0.68	12.19	0.66	2874.0	84	492	343.12	23	133	92.64	1273
3	2410	0.60	12.21	0.71	2246.1	55	275	169.24	14	69	42.31	741
4	2308	0.57	12.26	0.69	1522.8	34	169	74.12	10	52	22.98	594
5	3642	0.55	11.85	1.40	73.3	10	29	0.65	0	1	0.03	17
						Weighted Total Mass Emissions, g/hr			**66.4**	**716**	**202.0**	**3854**
						Weighted Specific Mass Emissions, g/kW-hr			**6.32**	**68.2**	**19.2**	**367**

Mode	Exh back	Cell Air	Engine Coolant			Weight	Fuel Temp	Dry H2 Conc	Dry to Wet	Calculated	Trapping	Total
	Press, psi	Temp, C	Inlet, C	Outlet, C	Press, psi	Factor	C	%	Corr. Factor	AFR	Efficiency	Emissions
1	0.003	27.2	26.5	43.6	14.3	0.12	44.32	1.05	0.88	13.13	0.99	97.06
2	0.003	27.4	26.3	43.8	15.7	0.27	44.30	0.24	0.88	14.53	0.97	97.26
3	0.003	27.1	26.1	43.2	15.7	0.25	43.97	0.22	0.88	14.58	0.96	97.03
4	0.003	26.7	26.0	42.7	16.0	0.31	43.15	0.20	0.88	14.56	0.96	96.92
5	0.003	26.7	26.1	42.7	16.0	0.05	40.63	0.20	0.89	14.92	0.93	96.35

EXHAUST EMISSIONS ANALYSIS, Test Cell # 3

Engine Tested: 97 THUNDER CAT 900 ISMA EMISSIONS RETEST W/ 390 MAINS,JETTED FOR TEST CELL CONDITIONS

Test Date: 11/17/98 **Report Date:** 11/17/98 **Run Number:** 720

Mode	SPEED	Torque	Power	Intake	Baro.	Water Vapor	Relative	EPA "f"	Fuel Pres.	Fuel Flow	BSFC	Run
	rpm	N-m	kW	Air, Deg. C	kPa	Press, kPa	Humidity	Factor	Psi	g / hr	lbs / hp-hr	Number
1	8399	122.2	107.5	17.1	98.0	1.50	76.9	1.006	3.0	42964	0.63	720
2	7140	67.2	50.2	16.9	98.0	1.45	75.8	1.005	3.2	20856	0.65	720
3	6300	41.3	27.2	16.6	98.0	1.50	79.2	1.005	3.3	12004	0.69	720
4	5461	24.6	14.0	16.5	98.0	1.53	81.4	1.005	3.3	7921	0.89	720
5	1807	2.7	0.4	17.0	98.0	1.56	80.4	1.007	3.4	1307	4.80	720

Mode	THC	CO	CO2	O2	NOx	Mass Emissions, g/hr			Weighted Mass Emissions, g/hr			Weighted Fuel Flow
	ppm C	%	%	%	ppm	HC's	CO	NOx	HC's	CO	NOx	g / hr
1	40763	6.53	6.69	3.58	196.6	10125	32765	161.93	1215	3932	19.43	5156
2	36640	6.78	6.64	3.49	113.1	4474	16710	45.82	1208	4512	12.37	5631
3	44028	4.94	6.97	4.64	91.6	3240	7335	22.35	810	1834	5.59	3001
4	55422	3.47	6.86	6.16	89.9	2766	3494	14.88	857	1083	4.61	2455
5	65831	1.37	3.14	14.06	81.2	775	326	3.17	39	16	0.16	65
						Weighted Total Mass Emissions, g/hr :			**4129**	**11377**	**42.2**	**16309**
						Weighted Specific Mass Emissions, g/kW-hr :			**114**	**314**	**1.2**	**450**

Mode	Exh back	Cell Air	Engine Coolant			Weight	Fuel Temp	Dry H2 Conc	Dry to Wet	Calculated	Trapping	Total
	Press, psi	Temp, C	Inlet, C	Outlet, C	Press, psi	Factor	C	%	Corr. Factor	AFR	Efficiency	Emissions
1	1.246	22.7	40.0	60.2	38.0	0.12	25.97	3.31	0.91	10.38	0.80	98.00
2	1.246	23.5	52.7	60.6	35.3	0.27	26.46	3.47	0.91	10.51	0.81	97.96
3	1.245	23.1	52.3	59.5	36.2	0.25	27.09	2.31	0.91	11.21	0.75	97.59
4	1.245	22.9	52.4	58.7	36.6	0.31	27.69	1.50	0.92	11.71	0.67	97.39
5	1.245	22.2	47.2	50.8	3.4	0.05	27.41	0.55	0.96	17.62	0.28	96.30

EXHAUST EMISSIONS ANALYSIS, Test Cell # 3

Engine Tested: 97 Z440 ISMA EMISSIONS RETEST W/ 240 MAINS,JETTED FOR TEST CELL CONDITIONS

Test Date: 11/18/98 **Report Date:** 11/18/98 **Run Number:** 722

Mode	SPEED	Torque	Power	Intake	Baro.	Water Vapor	Relative	EPA "f"	Fuel Pres.	Fuel Flow	BSFC	Run
	rpm	N-m	kW	Air, Deg. C	kPa	Press, kPa	Humidity	Factor	Psi	g / hr	lbs / hp-hr	Number
1	7199	48.2	36.3	23.6	97.1	1.42	49.1	1.031	3.3	15274	0.65	722
2	6120	26.8	17.2	23.0	97.1	1.46	51.8	1.030	3.4	7867	0.71	722
3	5401	16.6	9.3	22.6	97.1	1.49	54.4	1.029	3.4	4666	0.77	722
4	4686	9.8	4.8	22.7	97.0	1.51	54.7	1.030	3.4	4504	1.46	722
5	1273	1.9	0.2	22.5	97.0	1.54	56.5	1.030	3.5	699	5.15	722

Mode	THC	CO	CO2	O2	NOx	Mass Emissions, g/hr			Weighted Mass Emissions, g/hr			Weighted Fuel Flow
	ppm C	%	%	%	ppm	HC's	CO	NOx	HC's	CO	NOx	g / hr
1	44536	5.17	6.96	4.82	512.6	4103	9611	156.62	492	1153	18.79	1833
2	28730	9.20	6.04	2.77	103.2	1248	8071	14.87	337	2179	4.01	2124
3	34100	6.69	6.96	3.52	77.2	933	3695	7.00	233	924	1.75	1167
4	82202	6.59	4.52	7.31	104.3	1915	3102	8.06	594	961	2.50	1396
5	110504	4.52	4.36	9.34	119.7	388	320	1.39	19	16	0.07	35
Weighted Total Mass Emissions, g/hr :									**1675**	**5234**	**27.1**	**6555**
Weighted Specific Mass Emissions, g/kW-hr :									**137**	**428**	**2.2**	**536**

Mode	Exh back	Cell Air	Engine Coolant			Weight	Fuel Temp	Dry H2 Conc	Dry to Wet	Calculated	Trapping	Total
	Press, psi	Temp, C	Inlet, C	Outlet, C	Press, psi	Factor	C	%	Corr. Factor	AFR	Efficiency	Emissions
1	1.170	25.4	12.8	14.6	0.8	0.12	18.38	2.44	0.91	11.23	0.74	99.62
2	1.235	25.2	14.0	16.4	0.4	0.27	19.17	5.23	0.91	9.98	0.85	100.79
3	1.245	24.7	15.1	18.1	0.3	0.25	20.20	3.38	0.90	10.78	0.81	100.11
4	1.245	24.0	16.1	19.5	0.3	0.31	21.36	3.61	0.93	9.59	0.61	100.31
5	1.197	20.8	16.8	20.4	0.4	0.05	21.49	2.24	0.94	9.47	0.51	100.35

EXHAUST EMISSIONS ANALYSIS, Test Cell # 3

Engine Tested: 97 ZR600 ISMA EMISSIONS RETEST W/ 330 MAINS,JETTED FOR TEST CELL CONDITIONS

Test Date: 11/19/98 **Report Date:** 11/19/98 **Run Number:** 725

Mode	SPEED	Torque	Power	Intake	Baro.	Water Vapor	Relative	EPA "f"	Fuel Pres.	Fuel Flow	BSFC	Run
	rpm	N-m	kW	Air, Deg. C	kPa	Press, kPa	Humidity	Factor	Psi	g / hr	lbs / hp-hr	Number
1	8399	79.8	70.2	13.2	97.7	1.63	107.5	1.001	1.8	29224	0.65	725
2	7140	41.6	31.1	12.2	97.6	1.53	108.0	0.999	1.9	18144	0.92	725
3	6306	25.1	16.5	16.6	97.7	1.46	77.5	1.008	1.9	14368	1.36	725
4	5463	15.4	8.7	18.1	97.7	1.43	69.0	1.011	1.9	8866	1.59	725
5	1900	2.7	0.5	18.0	97.7	1.44	69.8	1.011	2.0	1269	4.00	725

Mode	THC	CO	CO2	O2	NOx	Mass Emissions, g/hr			Weighted Mass Emissions, g/hr			Weighted Fuel Flow
	ppm C	%	%	%	ppm	HC's	CO	NOx	HC's	CO	NOx	g / hr
1	41474	7.03	6.43	3.94	173.6	6883	23566	95.57	826	2828	11.47	3507
2	58130	8.31	5.00	5.26	97.3	5514	15924	30.62	1489	4299	8.27	4899
3	96980	7.00	3.92	8.02	126.0	6756	9853	29.12	1689	2463	7.28	3592
4	100404	6.14	3.96	8.73	120.6	4419	5456	17.60	1370	1691	5.46	2749
5	127603	3.42	3.69	11.54	124.8	815	441	2.64	41	22	0.13	63
Weighted Total Mass Emissions, g/hr :									**5415**	**11304**	**32.6**	**14810**
Weighted Specific Mass Emissions, g/kW-hr :									**229**	**478**	**1.4**	**626**

Mode	Exh back	Cell Air	Engine Coolant			Weight	Fuel Temp	Dry H2 Conc	Dry to Wet	Calculated	Trapping	Total
	Press, psi	Temp, C	Inlet, C	Outlet, C	Press, psi	Factor	C	%	Corr. Factor	AFR	Efficiency	Emissions
1	0.402	12.3	45.6	60.7	38.7	0.12	19.67	3.66	0.91	10.38	0.79	99.94
2	0.369	12.1	51.5	59.6	38.7	0.27	20.20	4.76	0.92	9.63	0.72	101.40
3	0.486	21.6	51.3	59.6	39.2	0.25	20.33	4.02	0.94	9.06	0.57	101.42
4	0.526	21.7	51.9	58.5	38.7	0.31	20.68	3.39	0.94	9.35	0.54	101.19
5	0.541	20.5	48.0	51.1	3.6	0.05	20.69	1.63	0.95	9.71	0.40	100.77

EXHAUST EMISSIONS ANALYSIS, Test Cell # 3

Engine Tested: 97 ZRT 600 ISMA EMISSIONS RETEST W/340 MAINS,JETTED FOR TEST CELL CONDITIONS

Test Date: 11/20/98 **Report Date:** 11/20/98 **Run Number:** 728

Mode	SPEED	Torque	Power	Intake	Baro.	Water Vapor	Relative	EPA "f"	Fuel Pres.	Fuel Flow	BSFC	Run
	rpm	N-m	kW	Air, Deg. C	kPa	Press, kPa	Humidity	Factor	Psi	g / hr	lbs / hp-hr	Number
1	8399	97.4	85.6	21.3	98.0	1.43	56.8	1.016	1.8	34120	0.62	728
2	7140	51.6	38.6	23.9	98.0	1.37	46.4	1.022	1.9	16534	0.67	728
3	6316	32.1	21.2	24.5	98.0	1.40	45.8	1.023	2.0	11173	0.82	728
4	5474	19.2	11.0	23.7	98.0	1.44	49.4	1.022	2.0	7601	1.08	728
5	1995	3.2	0.6	23.7	98.0	1.48	50.6	1.022	2.1	1559	4.11	728

Mode	THC	CO	CO2	O2	NOx	Mass Emissions, g/hr			Weighted Mass Emissions, g/hr			Weighted Fuel Flow
	ppm C	%	%	%	ppm	HC's	CO	NOx	HC's	CO	NOx	g / hr
1	48306	4.58	6.98	5.41	461.5	10053	19260	318.55	1206	2311	38.23	4094
2	38218	7.42	6.07	4.32	121.7	3651	14314	38.56	986	3865	10.41	4464
3	51606	6.26	5.63	5.98	92.8	3382	8284	20.16	845	2071	5.04	2793
4	69280	4.72	5.15	8.11	99.1	3135	4314	14.88	972	1337	4.61	2356
5	55353	1.52	1.73	16.38	89.0	982	544	5.24	49	27	0.26	78
Weighted Total Mass Emissions, g/hr :									**4058**	**9612**	**58.6**	**13786**
Weighted Specific Mass Emissions, g/kW-hr :									**141**	**333**	**2.0**	**478**

Mode	Exh back	Cell Air	Engine Coolant			Weight	Fuel Temp	Dry H2 Conc	Dry to Wet	Calculated	Trapping	Total
	Press, psi	Temp, C	Inlet, C	Outlet, C	Press, psi	Factor	C	%	Corr. Factor	AFR	Efficiency	Emissions
1	0.214	20.3	39.5	60.1	39.0	0.12	26.07	2.10	0.91	11.48	0.71	99.94
2	0.304	22.7	52.6	59.8	36.4	0.27	26.51	3.96	0.91	10.63	0.77	100.22
3	0.338	23.2	52.3	59.3	37.1	0.25	26.80	3.23	0.92	10.91	0.68	99.64
4	0.341	22.7	52.0	58.6	37.9	0.31	27.17	2.30	0.93	11.27	0.57	99.44
5	0.335	22.3	47.2	50.9	4.0	0.05	27.18	0.70	0.98	22.67	0.18	97.12

Rec'd 11/13/01 FWR

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November 8, 2001

Mr. Steven Iobst
Acting Superintendent
Grand Teton National Park
P.O. Drawer 170
Moose, WY 83012

Dear Mr. Iobst:

Enclosed is the latest emissions data from a production model four-stroke engine snowmobile manufactured by Arctic Cat. Testing was done according to established protocols. The results confirm the findings from previous tests on prototypes that these new engines reduce hydrocarbon (HC) emissions by 95.8 percent and carbon monoxide (CO) by 85.2 percent. The HC reduction is consistent with the prototype models, however, CO emissions have been further reduced in this production model (85.2 percent compared to 82.8 percent for the prototype). The specific test results information is attached.

The International Snowmobile Manufacturers Association (ISMA) continues to maintain that rapid conversion of the snowmobile rental fleet at Yellowstone and Grand Teton to new technology snowmobiles (i.e., four strokes, direct injection two strokes) will permit continuation of traditional snowmobiling, reduction of emissions and assure no violation of applicable ambient air standards and no impairment of park resources.

Sincerely,

BIRCH, HORTON, BITTNER
AND CHEROT

William P. Horn

Enclosure

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EXHAUST EMISSIONS ANALYSIS, Test Cell # 3

Engine Tested: 2002 C TECH 4 S/N 5128642

Test Date: 11/05/01 **Report Date:** 11/7/2001 **Run Number:** 2559

Mode	SPEED	Torque	Power	Intake	Baro.	Water Vapor	Relative	EPA "f"	Fuel Pres.	Fuel Flow	BSFC	Run
	rpm	N-m	kW	Air, Deg. C	kPa	Press, kPa	Humidity	Factor	Psi	g / hr	lbs / hp-hr	Number
1	6166	50.0	32.2	13.5	97.5	0.99	64.2	0.998	4.0	9912	0.51	2559
2	5256	26.2	14.4	13.0	97.5	1.07	71.9	0.998	4.0	4595	0.52	2559
3	4635	16.0	7.7	12.4	97.4	1.00	69.2	0.996	4.0	2819	0.60	2559
4	4009	9.4	3.9	12.1	97.4	0.76	53.6	0.993	4.0	1810	0.76	2559
5	1304	1.4	0.2	12.8	97.4	0.80	54.4	0.994	4.0	449	4.67	2559

Mode	THC	CO	CO2	O2	NOx	Mass Emissions, g/hr			Weighted Mass Emissions, g/hr			Weighted Fuel Flow
	ppm C	%	%	%	ppm	HC's	CO	NOx	HC's	CO	NOx	g / hr
1	2560	3.22	11.17	0.17	1519.4	173	4398	341.19	20.80	527.8	40.94	1189
2	2369	0.37	12.63	0.70	2957.2	82	261	340.39	22.19	70.6	91.90	1241
3	2519	0.16	12.42	1.23	2744.5	55	72	200.01	13.84	18.0	50.00	705
4	2553	0.19	12.44	1.16	1618.1	36	54	75.39	11.12	16.8	23.37	561
5	4915	1.77	11.94	0.44	100.5	16	113	1.06	0.78	5.6	0.05	22
					Weighted Total Mass Emissions, g/hr :				68.7	638.8	206.3	3718
					Weighted Specific Mass Emissions, g/kW-hr :				6.33	58.8	19.0	342

Mode	Exh back	Cell Air	Engine Coolant			Weight	Fuel Temp	Dry H2 Conc	Dry to Wet	Calculated	Trapping	Total
	Press, psi	Temp, C	Inlet, C	Outlet, C	Press, psi	Factor	C	%	Corr. Factor	AFR	Efficiency	Emissions
1	0.031	23.1	76.8	80.8	8.0	0.12	19.46	1.33	0.88	12.83	0.99	99.53
2	0.031	22.0	77.3	80.2	8.0	0.27	18.83	0.13	0.88	14.73	0.96	99.55
3	0.031	21.4	76.8	78.9	8.0	0.25	17.89	0.06	0.88	15.24	0.94	99.07
4	0.031	21.0	77.9	79.4	8.0	0.31	17.03	0.07	0.88	15.12	0.94	98.70
5	0.031	20.7	76.3	77.0	8.0	0.05	16.89	0.68	0.88	13.44	0.98	99.29